

MIL-S-19500/271A (NAVY)

14 February 1964

~~SUPERSEDING~~

MIL-S-19500/271 (NAVY)

21 October 1963

(See 6.2)

**MILITARY SPECIFICATION**  
**SEMICONDUCTOR DEVICE, TRANSISTOR**  
**TYPE 2N916**

**1. SCOPE**

1.1 This specification covers the detail requirements for an NPN-silicon transistor and is in accordance with Specification MIL-S-19500, except as otherwise specified herein.

1.2 Mechanical dimensions and outlines. - TO-18 (see figure 1).

1.3 Absolute maximum ratings. -

$P_t$ (WATTS) <sup>1/</sup>			$V_{CB}$	$V_{CEO}$	$V_{EB}$	$I_C$ (mA)	$T_J$	$T_{stg}$
$T_C = 25^\circ\text{C.}$	$T_C = 100^\circ\text{C.}$	$T_A = 25^\circ\text{C.}$						
1.2	0.68	0.36	+45	+25	+5.0	50	200°C.	-85° to 200°C.

<sup>1/</sup>See figure 2.

1.4 Primary electrical characteristics. -

	$h_{FE} @ V_{CE} = 1.0V, T_A = +35^\circ\text{C.}$ (Unless otherwise noted)		$h_{fe} @ 100\text{ mc}$ $I_C = 10\text{mA}, V_{CE} = 15V$	
	$I_C = 10\text{mA}$	$I_C = 10\text{mA}$ $T_A = -55^\circ\text{C.}$		
Min.	50	15	3.0	
Max.	200	--	---	

	$h_{fe}$		$h_{oe} (\mu\text{mho})$		$h_{ie} (\text{ohms})$	
	$I_C = 1\text{mA}$ $V_{CE} = 5V$	$I_C = 5\text{mA}$ $V_{CE} = 5V$	$I_C = 1\text{mA}$ $V_{CE} = 5V$	$I_C = 5\text{mA}$ $V_{CE} = 5V$	$I_C = 1\text{mA}$ $V_{CE} = 5V$	$I_C = 5\text{mA}$ $V_{CE} = 5V$
Min.	40	50	---	---	----	----
Max.	200	250	75	125	6000	2000

	Capacitance- $\mu\text{mf}$		$V_{CE} (\text{SAT})$	$V_{BE} (\text{SAT})$	NF
	$C_{ob}$	$C_{ib}$			
	$I_E = 0$ $V_{CB} = 5V$	$I_C = 0$ $V_{EB} = 0.5V$	$I_C = 10\text{mA}$ $I_B = 1.0\text{mA}$	$I_C = 10\text{mA}$ $I_B = 1.0\text{mA}$	$I_C = 1.0\text{mA}$ $V_{CE} = 5.0V$ $f = 1\text{mc}$ $bw \leq 200\text{kc}$ $R_G = 1000\Omega$
Min.	---	--	----	----	----
Max.	6.0	10	0.5V	0.9V	8 db

1.5 Reliability ratings (at 90 percent confidence).-

Test	Steady state operation life	High temperature life (nonoperating)
Conditions	$T_A = 25^\circ \pm 3^\circ\text{C}.$ $V_{CB} = 20\text{V}, I_C = 18\text{mA}$	$T_A = 200^\circ\text{C}.$
%/1000 hrs.	$\lambda = 10\%$	$\lambda = 10\%$

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATION

MILITARY

MIL-S-19491 - Semiconductor Devices, Preparation for Delivery of.  
MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General.- Transistors shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Design, construction and physical dimensions.- Transistors shall be of the design, construction and physical dimensions shown on figure 1.

3.3 Performance characteristics.- Performance characteristics shall be as specified in 4.2.1, 4.2.2 and 4.2.3.

3.4 Marking.- The following marking specified in MIL-S-19500 may be omitted from the device:

- (a) Country of origin.
- (b) Manufacturer's identification.

3.4.1 The device shall be marked with the "USN" prefix in lieu of the "JAN" prefix.

4. QUALITY ASSURANCE PROVISIONS

4.1 Qualification tests.- Qualification tests shall be conducted at a laboratory satisfactory to the Bureau of Ships. Qualification tests shall consist of the tests specified in 4.2.1, 4.2.2 and 4.2.3. (Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.1)).

4.2 Acceptance inspection.- Acceptance inspection shall consist of the examinations and tests specified in 4.2.1, 4.2.2 and 4.2.3.

4.2.1 Group A inspection.- Group A inspection shall consist of the examination and tests shown in table I.

4.2.2 Group B inspection.- Group B inspection shall consist of the examinations and tests shown in table II.

4.2.2.1 Destructive tests.- Tests listed in subgroups 2, 3, 4 and 5 are considered destructive.

4.2.2.2 Salt atmosphere.- The device shall be examined for destructive corrosion and illegible marking.

4.2.3 Group C inspection.- Group C inspection shall consist of the examinations and tests shown in table III. This inspection shall be conducted on the initial lot, and thereafter every 90 days or every fifth lot, whichever occurs first.

4.2.4 Acceptance-inspection information.- When specified in the contract or order, one copy of the acceptance-inspection information pertinent to the transistor inspection lot shall be furnished by the transistor supplier and shall accompany each transistor shipment from the inspection lot to the equipment manufacturer.

4.3 Inspection of preparation for delivery.- Sample items and packs shall be selected and inspected in accordance with MIL-S-18491 to verify conformance with requirements in section 5 of this specification.

## 5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery.- The transistors shall be prepared for delivery in accordance with MIL-S-18491.

## 6. NOTES

6.1 The activity responsible for the qualified products list is the Bureau of Ships, Department of the Navy, Washington 25, D. C., and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification." (Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia 20, Pa.)

6.2 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "4" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Preparing activity:

Navy - Ships

(Project 5960-N429(NAVY))

Table I - Group A inspection.

Examination or test	Conditions		LTPD	Min. rej. No.	Symbol	Limits		Unit
	MIL-STD-750 method	Specific Conditions				Min.	Max.	
<u>Subgroup 1</u>								
Visual and mechanical examination	3071		5	4				
<u>Subgroup 2</u>								
Collector-base breakdown voltage	3001 Condition D	$I_C = 10 \mu A$	5	4	$BV_{CBO}$	45	---	Vdc
Emitter-base breakdown voltage	3026 Condition D	$I_E = 10 \mu A$			$BVEBO$	5.0	---	Vdc
Collector-emitter break-down voltage	3011 Condition D (Pulsed)	$I_B = 0$ $I_C = 30 \text{ mA}$ $t_p \leq 300 \mu\text{sec}$ duty cycle $\leq 2\%$			$BV_{CEO}$	25	---	Vdc
Collector-base cut-off current	3036 Condition D	$V_{CB} = 30 \text{ V}$			$I_{CBO}$	---	10	mAac
Static-forward current transfer ratio	3076 (Pulsed)	$V_{CE} = 1.0 \text{ V}$ $I_C = 10 \text{ mA}$ $t_p \leq 300 \mu\text{sec}$ duty cycle $\leq 2\%$			$h_{FE}$	50	200	
Collector saturation voltage	3071	$I_C = 10 \text{ mA}$ $I_B = 1.0 \text{ mA}$	5	4	$V_{CE}(\text{SAT})$	---	0.5	Vdc
# Base saturation voltage	3066 Condition A	$I_C = 10 \text{ mA}$ $I_B = 1.0 \text{ mA}$			$V_{BE}(\text{SAT})$	---	0.9	Vdc
<u>Subgroup 3</u>								
Small-signal forward-current transfer ratio	3206	$I_C = 1 \text{ mA}$ $V_{CE} = 5 \text{ V}$ $f = 1 \text{ kc}$ $I_C = 5 \text{ mA}$ $V_{CE} = 5 \text{ V}$ $f = 1 \text{ kc}$ $I_C = 10 \text{ mA}$ $V_{CE} = 15 \text{ V}$ $f = 100 \text{ mc}$	10	5	$h_{fe}$	40	200	
					$h_{fe}$	50	250	
					$h_{fe}$	3.0	---	
# Small-signal short-circuit input impedance	3201	$I_C = 5.0 \text{ mA}$ $V_{CE} = 5.0 \text{ V}$ $f = 1 \text{ kc}$			$h_{ie}$		2000	ohms

Table I - Group A inspection (cont'd.).

Examination or test	Conditions		LTPD	Min. rej. No.	Symbol	Limits		Unit
	MIL-STD-750 method	Specific Conditions				Min.	Max.	
Small-signal open-circuit output admittance	3216	$I_C = 5.0 \text{ mA}$ $V_{CE} = 5.0 \text{ V}$ $f = 1 \text{ kc}$	10	5	$h_{oe}$	---	125	$\mu\text{mhos}$
Subgroup 4								
Output capacitance	3236	$V_{CB} = 5.0 \text{ V}$			$C_{ob}$	---	6.0	pf
Low temperature operation								
Static forward current transfer ratio	3076	$T_A = -55^\circ\text{C. Max.}$ $I_C = 10 \text{ mA dc}$ $V_{CE} = 1.0 \text{ V}$			$h_{FE}$	15	---	
High temperature operation		$T_A = 150^\circ \pm 3^\circ\text{C.}$						
Collector-base cut-off current	3036 Condition D	$V_{CB} = 30 \text{ V}$			$I_{CBO}$	---	10	$\mu\text{A dc}$

Table II - Group B inspection.

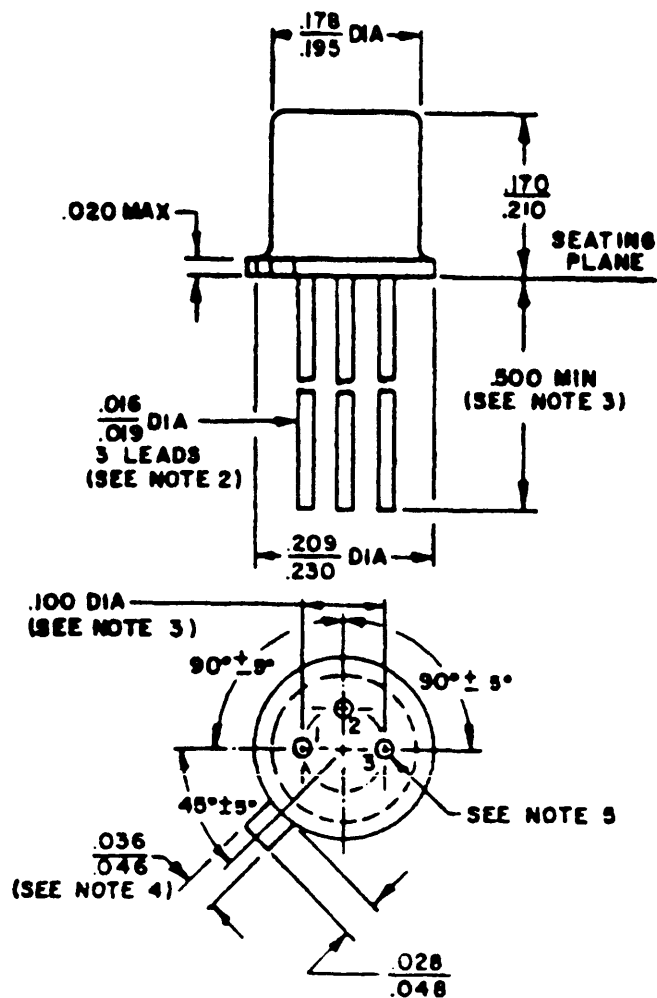
Examination or test	Conditions		LTPD	Min. rej. No.	Symbol	Limits		Unit
	MIL-STD-750 method	Specific Conditions				Min.	Max.	
Subgroup 1								
Physical dimensions	2066		20	4				
Subgroup 2								
Solderability	2026		10	5				
Temperature cycling	1051 Condition C							
Thermal shock	1056 Condition A							
Moisture resistance	1021							
Subgroup 3								
Shock	2016	Nonoperating, 1500G 1 msec 5 blows each orientation: $Y_1, Y_2, X_1$ and $Z_1$						

Table II - Group B inspection (cont'd.).

Examination or test	Conditions		LTPD	Min. rej. No.	Symbol	Limits		Units				
	MIL-STD-750 method	Specific Conditions				Min.	Max.					
Vibration fatigue	2046	Nonoperating	10	5								
Vibration, variable frequency	2056											
Constant accelera- tion	2006	20,000G each orientation: Y <sub>1</sub> , Y <sub>2</sub> , X <sub>1</sub> and Z <sub>1</sub>										
<u>Subgroup 4</u>												
Terminal strength	3036 Condition E		20	4								
<u>Subgroup 5</u>												
Salt atmosphere (corrosion)	1041		20	4								
Endpoints for sub- groups 2, 3, and 5:												
Collector cut-off current	3036 Condition D	V <sub>CB</sub> = 30 V							I <sub>CBO</sub>	---	0.02	μAdc
Collector satura- tion voltage	3071	I <sub>C</sub> = 10 mA I <sub>B</sub> = 1.0 mA							V <sub>CE</sub> (SAT)	---	0.55	Vdc
Base saturation voltage	3066 Condition A	I <sub>C</sub> = 10 mA I <sub>B</sub> = 1.0 mA			V <sub>BE</sub> (SAT)	---	0.99	Vdc				
<u>Subgroup 6</u>												
High temperature life (nonoperating)	1031	T <sub>A</sub> = 200°C. min.	λ = 10									
<u>Subgroup 7</u>												
Steady state opera- tion life	1026	T <sub>A</sub> = 25° ± 3°C. V <sub>CB</sub> = 20 V I <sub>C</sub> = 18 mAdc	λ = 5									
Endpoints for sub- groups 6 and 7:												
Collector cut-off current	3036 Condition D	V <sub>CB</sub> = 30 V			I <sub>CBO</sub>	---	0.02	μAdc				
Static forward cur- rent transfer ratio	3076	V <sub>CE</sub> = 1.0 V I <sub>C</sub> = 10 mAdc t <sub>p</sub> ≤ 300 μsec Duty cycle ≤ 2%			Δh <sub>FE</sub>	---	±25%	% of initial recorded value				

Table III - Group C Inspection.

Examination or test	Conditions		LTPD	Min. rej. No.	Symbol	Limits		Unit
	MIL-STD-750 method	Specific Conditions				Min.	Max.	
<u>Subgroup 1</u>								
Small-signal short-circuit input impedance	3201	$I_C = 1 \text{ mA}$ $V_{CE} = 5 \text{ V}$	5	4	$h_{ie}$	---	6000	ohms
Small-signal open-circuit output admittance	3216	$I_C = 1 \text{ mA}$ $V_{CE} = 5 \text{ V}$			$h_{oe}$	---	75	$\mu\text{mho}$
Input capacitance	3240	$I_C = 0$ , $V_{EB} = -0.5 \text{ V}$			$C_{ib}$	---	10	pf
Noise figure	3246	$I_C = 1.0 \text{ mA}$ $V_{CE} = 5.0 \text{ V}$ $R_g = 1000 \Omega$ $b_w = 200 \text{ Hz}$ $f = 1 \text{ kHz}$			NF		8	db
<u>Subgroup 2</u>								
Thermal resistance	3151		20	4	$\theta_{JC}$	---	0.145	$^{\circ}\text{C/mW}$
Barometric pressure, (reduced altitude operation)	1001	15mmHg $V_{CB} = 30 \text{ V}$ $I_E = 0$			$I_{CBO}$	---	10	$\text{mAAdc}$



1. All dimensions in inches.
2. The specified lead diameter applies in the zone between 0.050 and 0.250 from the seating plane, in the zone between 0.250 and end of lead, a maximum of 0.021 diameter is held. Outside of these zones, the lead diameter is not controlled.
3. Leads having maximum diameter (0.019) measured in a gaging plane  $0.054 \pm 0.001$  below the seating plane of the transistor shall be within 0.007 of their true locations relative to the maximum-width tab and to the maximum 0.230 diameter measured with a suitable gage. When a gage is not used, measurements shall be made at the seating plane.
4. Index tab is for visual orientation only.
5. The collector shall be internally connected to the case.
6. Lead arrangement:

Lead 1	.....	Emitter
Lead 2	.....	Base
Lead 3	.....	Collector

Figure 1 - Outline dimensions of transistor, type 2N916.



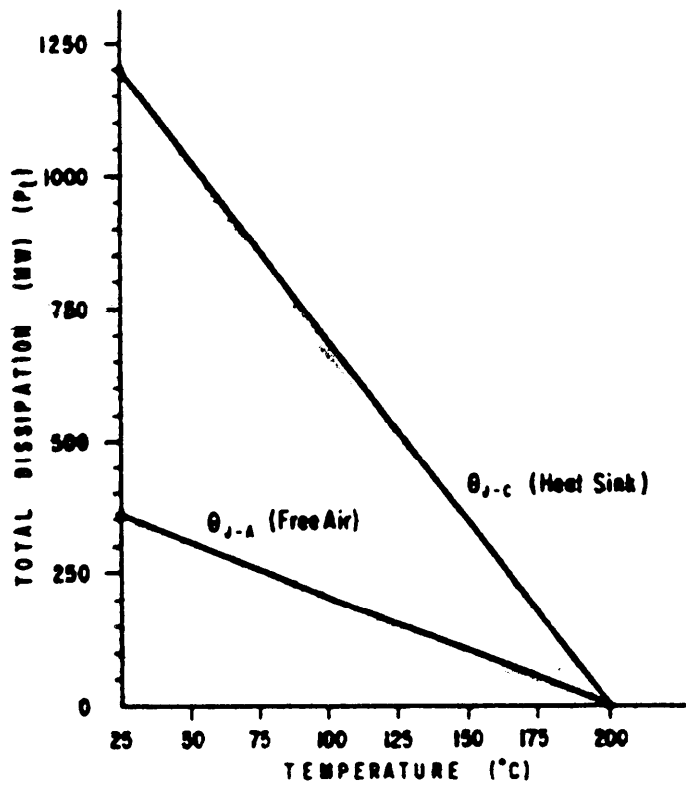


Figure 2 - Power dissipation, temperature derating curve.

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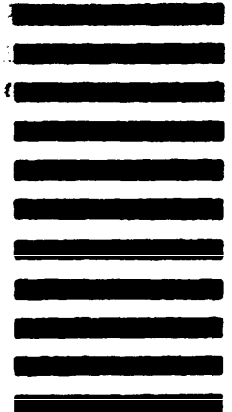
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